

Review of Medical Imaging competencies for Image Interpretation Capability

Background

The Department of Health (DoH) Queensland contracted Monash University to define core image interpretation competencies for entry level registration and in addition to include advanced level image interpretation competencies that an advanced radiographer would undertake. Two surveys were distributed to all nine Australian Universities offering accredited Australian Medical Radiation programs of study. The first survey was related to entry level diagnostic radiography practitioners and the second survey related to advanced level radiography practitioners.

This report, based on analysis of the surveys distributed, aims to outline relevant standards relating to image interpretation for entry level and advanced level diagnostic radiography practitioners and map image interpretation curriculum and content.

Historical background

Australian Institute of Radiography (AIR)

Prior to July 2012 the AIR issued the “Guidelines for Professional conduct for Radiographers¹, Radiation Therapists and Sonographers”. The “Code of Practice for Radiographers” included the following statement:

“Radiographers, recognising their responsibility to the patient, should alert medically significant findings to the medical personnel responsible for the patient’s treatment and at the request of such personnel may provide an opinion that lies within their knowledge and expertise”.

Guidance notes for radiographers within the AIR ‘Code of Practice for Radiographers¹’ included the following:

- Radiographers may provide descriptions of images as part of an accepted written protocol that is authorised by the employing authority.
- Radiographers have a general responsibility to provide information and an opinion that lies within their knowledge and expertise and they should take reasonable precautions to ensure that such information and opinion are both accurate and appropriate in the circumstances of the case.

Medical Radiation Practice Board of Australia (MRPBA) joined the **Australian Health Practitioner Regulation Agency (AHPRA)** from the 1 July 2012. The AHPRA undertook a consultation paper seeking feedback on “Professional capabilities for medical radiation practice” (dated 11 June 2013²). It is worthwhile to note the following from the draft consultation paper which is of particular interest to the entry-level review:

Domain 6A: Practice in Diagnostic radiography

What registered practitioners must be able to do:	Ways that this capability will be demonstrated at entry or re-entry to the profession
1. Implement and evaluate projection radiography examinations for a range of patient/client presentations and complexities	i. Evaluating radiographic images and applying radiographic criteria to these images. j. Applying knowledge of human disease and trauma processes to the evaluation of projection radiography images.

<p>2. Provide a verbal radiographic opinion about any abnormal element in a radiographic image set</p>	<p>a. Understanding of the legal framework for providing the opinion. b. Having thorough knowledge of the typical radiographic appearances of common disease processes and trauma affecting the axial and appendicular skeleton, chest and abdomen.</p>
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AHPRA also undertook a consultation paper seeking feedback on “Codes of Conduct (2013)³”. Specific provisions for medical radiation practitioners (Appendix A³) of this draft document included the following;

Effective communication:

“In the usual course of medical radiation practice, communication about the results of diagnostic tests or therapeutic interventions should be between the referring health practitioner and the radiologist, nuclear medicine physician or radiation oncologist and as part of the clinical team this can include the medical radiation practitioner.”

It was also stated within the draft consultation paper that providing descriptions to the outcome of diagnostic investigations would be consistent with provision of good care. However, the document³ drew attention to the fact that in providing such descriptions, medical radiation practitioner should be mindful of:

- their clinical experience, formal training and assessed competence to provide such descriptions
- the established criteria and local policy related to providing such descriptions, and
- the clinical context of the enquiry and the seriousness of the diagnosis or treatment

The assumption could therefore be made that it will be a requirement that entry level diagnostic radiographers must be capable of providing an opinion on common disease processes and trauma affecting the axial and appendicular skeleton, chest and abdomen. However this does not fully address the process of how imaging findings would be documented by diagnostic radiographers.

Analysis of entry level image interpretation capabilities survey of accredited Australian Medical Radiation programs of study

Analysis of course content

Data analysed revealed five themes related to image interpretation which includes clinical history, image quality, human anatomy, radiographic anatomy and normal variants, radiographic pathology and communication. Delivery of the level and depth of these identified criteria varies across the programs of study.

1. **Clinical history:** evaluating the request form and clinical history to aid in the diagnostic process the clinical information to inform the diagnostic process is offered across all participants. However, what is lacking is information regarding the importance of knowing the mechanism of injury when undertaking radiographic examinations and interpreting radiographic images.
2. **Image quality:** evaluating the ability to assess the technical quality of radiographic images; critically discussing factors affecting image quality and recommending problem-solving strategies are common in all programs of study.
3. **Human anatomy:** as expected human anatomy including sectional anatomy is covered in depth.
4. **Radiographic anatomy and pathology:** the depth of course descriptions for these criteria varied significantly across programs of study. Radiographic anatomy and anatomical variations are covered in more detail. However, it is not evident to what depth and detail

radiographic pathology is offered. Lacking is information on whether appropriate search strategies are introduced to optimise recognition of trauma or common pathological processes when interpreting radiographic images.

5. **Communication:** the least information was provided on how appropriate verbal and written communication skills were offered or assessed within curriculums. Whilst generic communication skills are addressed in universities, only one university indicated the use of a radiographer opinion form. Communicating imaging findings to include a written comment is a critical skill that needs to be emphasised throughout all curricula offering medical radiations programs of study to ensure that graduates are skilled in using appropriate descriptive terminology.

A definition of image interpretation for entry level competencies was sought through the survey. From the feedback received, the following definition is proposed:

A new graduate entering the radiography profession must “at a beginner practitioner level, be able to assess plain film diagnostic images of the appendicular and axial skeleton and medical emergency conditions of the chest and abdomen in order to detect and distinguish the normal from common trauma and common disease processes and provide a written comment”.

The following definition of the scope of practice that a new graduate radiographer would be competent to undertake in relation to image interpretation and commenting is proposed:

“A new graduate formally educated at an accredited Australian university offering diagnostic radiography training should be able to communicate and provide a written comment on plain film diagnostic images of the appendicular and axial skeleton and medical emergency conditions of the chest and abdomen”.

The table below suggests standards that Australian Universities offering accredited Australian Medical Radiation programs of study must achieve to demonstrate that diagnostic radiographers are suitably trained to be capable of providing an opinion on radiographic images.

Standard	Element	Criteria
1. Demonstrate professional behaviour appropriate to radiography profession	1.1 Working within the limits of a practitioner’s competence and scope of practice	1.1.1 Entrenched in entry level radiography education 1.1.2 Practising in accordance with the current and accepted evidence base of the health profession 1.1.3 Seeking advice when patient needs are beyond the abilities and education of the registered practitioner.
2. Radiation protection	2.1 Justification of diagnostic imaging requests 2.2 Being able to justify the net benefit of the diagnostic investigation	2.1.1 Accepting referrals for diagnostic imaging only from a person authorised to make such a request 2.2.1 Analyse procedures to ensure justification, optimisation and the need for additional imaging

	2.3 Optimise the radiation protection of the patient	2.3.1 Able to apply the ALARA principles
3. Providing good patient care	3.1 Taking into account patient history	3.1.1 Apply patient care skills to determine extent of physical condition 3.1.2 Consider mechanism of injury to optimise diagnostic outcome
4. Knowledge and skills	4.1 Application of knowledge and skills	4.1.1 Have broad and coherent body of knowledge of human anatomy 4.1.2 Applying knowledge and skills by demonstrating initiative and judgement in problem-solving and decision making
5. Effective communication	5.1 Communicate appropriately and effectively with patients and other health practitioners 5.2 Document radiographic findings	5.1.1 Communicate appropriately with and provide relevant information to other stakeholders including members of the treating team 5.1.2 Communicating effectively with other team members 5.1.3 Communicating all relevant information in a timely way 5.2.1 Always communicating sufficient information about the patient to enable continuing care of the patient 5.2.2 Provide oral and brief written comments on radiographic findings.
6. Interpret and analyse diagnostic imaging findings	6.1 Provide image interpretation descriptions / comments	6.1.1 Apply appropriate image interpretation search strategy 6.1.2 Utilise relevant radiographic anatomy knowledge to discriminate between normal and abnormal findings 6.1.3 Demonstrate knowledge of common trauma and common pathologies of the appendicular and axial skeleton and emergency medical conditions of the chest and abdomen. 6.1.4 Utilise appropriate medical terminology to provide a brief description of

		radiographic imaging findings
7. Risk management	7.1 Working in practice and systems to reduce error 7.2 Respond appropriately to serious or medical emergency results	7.1.1 Provide an opinion on diagnostic images in the emergency setting to reduce image interpretation errors 7.1.2 Provide brief written documentation 7.2.1 Ensuring that a patient is referred when a serious or medical emergency condition has been identified during a radiographic examination.
8. Operate effectively with other health care practitioners	8.1 Collaborate with other health care practitioners	8.1.1 Work collaboratively within the health care team 8.1.2 Provide a brief radiographic comment or verbal communication within accepted protocols and procedures to other health care practitioners
9. Access, interpret and apply information to continuously improve practice	8.1 Demonstrate an up to date working knowledge and understanding of radiography practice	8.1.1 Actively engage in CPD 8.1.2 Engage in research activities and evidence based process to evaluate the effectiveness and efficiency of radiographic practice 8.1.3 Display an understanding of relevant legal issues and obligations

A requirement from the DoH Queensland was to map the image curriculum and content which is reflected in the table below.

Mapping of Entry Level Image Interpretation Curriculum and Content

Year Level	Descriptor	Learning Outcomes
1	1.1. Clinical history	1.1.1 Evaluate radiographic request form and clinical history in aid of diagnostic process 1.1.2 Consider mechanism of injury. 1.1.3 Assess the appropriateness of supplementary projections
	1.2 Image Quality	1.2.1 Demonstrate ability to assess the technical quality of plain film radiographs to include the appendicular and axial skeleton, chest and abdomen in a systematic order. 1.2.2 Demonstrate ability to critically discuss factors affecting image quality 1.2.3 Devise appropriate problem-solving strategies for less than optimal radiographic projections
	1.3 Human anatomy	1.3.1 Describe the typical shape, size, orientation and location of anatomical structures of the appendicular, axial, respiratory system and abdomen

	1.4. Radiographic anatomy and normal variants	1.4.1 Utilise interpretation skills to identify the normal radiographic anatomy on plain film radiographs of the appendicular and axial skeleton, chest and abdomen. 1.4.2 Apply an appropriate search strategy to discriminate the normal and anatomical variants of the appendicular and axial skeleton, chest and abdomen.
	1.5 Communication	1.5.1. Utilise appropriate verbal and written communication skills with patients and the health care team. 1.5.2 Build medical terminology skills

2	2.1 Clinical history	2.1.1. Discuss and justify methods of modifying the medical imaging examination to the clinical history 2.1.2 Critically evaluate radiographic images in the light of medical history and mechanism
	2.2 Image Quality	2.2.1 Critique radiographic images according to diagnostic criteria and identify necessary modifications
	2.3 Knowledge and skills	2.1.1 Enhance knowledge and skills of surface and relational anatomy of the appendicular and axial skeleton, respiratory system and abdomen 2.1.2 Explain the aetiology, epidemiology and pathogenesis of commonly imaged pathologies of the appendicular and axial skeleton, respiratory system and abdomen
	2.4. Radiographic anatomy and common pathology	2.4.1 Distinguish between normal and abnormal traumatic radiographic images of the appendicular and axial skeleton involving adults and paediatrics 2.4.2 Apply an appropriate search strategy to recognise common trauma and pathological processes on plain film radiographs to include the appendicular and axial skeleton, emergency chest and emergency abdomen
	2.5 Communication	2.5.1 Utilise appropriate medical terminology to describe and document radiographic findings of the appendicular and axial skeleton, emergency chest and emergency abdomen

3	3.1 Clinical history	3.1.1 Demonstrate familiarity and understanding for the rationale of clinical protocols at clinical rotation sites 3.1.2 Demonstrate a consolidation of skills in correctly interpret clinical requests 3.1.3 Synthesise clinical information gained from a variety of sources and interactions with radiographic appearances
	3.2 Image quality	3.2.1 Critically evaluate the diagnostic quality and efficiency of radiographs produced for a range of patient types and radiographic procedures 3.2.2 Analyse suitability of radiographs produced for accurate interpretation while considering the options provided in other various medial radiation science modalities to answer the clinical question.
	3.3 Knowledge and skills	3.3.1 Synthesise prior knowledge of anatomy, aetiology and pathology of the appendicular and axial skeleton, respiratory system and abdomen 3.3.2 Expand knowledge to include sectional anatomy
	3.4 Radiographic anatomy and common pathology	3.4.1 Synthesise prior learning from anatomy and pathology and apply facts, concepts and terms related to images of the major diseases of the appendicular and axial skeleton, respiratory system and abdomen and recognise their imaging appearances.

		3.4.2 Further enhance image interpretation skills with respect to radiographic anatomy and pathology of the appendicular and axial skeleton, emergency chest and emergency abdomen under the guidance of qualified practitioners
	3.5 Communication	3.5.1 Analyse and explain how an examination should be modified to accommodate for a particular situation 3.5.2 Demonstrate the ability to use appropriate medical terminology to construct a written comment on radiographic images 3.5.3 Outline the role and responsibilities of the radiographer in assessing radiographic images 3.5.3 Define and explain the legal issues affecting the practice of medical imaging

4	4.1 Clinical history and patient management	4.1.1 Be able to plan, conduct, review and interpret appropriate procedures in a setting of minimal supervision
	4.2 Image quality	4.2.1 Assess imaging outcomes for a range of examinations, exposure quality and overall diagnostic quality for a broad range of patient types and procedures.
	4.3 Knowledge and skills	4.3.1 Consolidate prior knowledge and skills to demonstrate transitioning from an advanced beginner to a competent practitioner
	4.4 Radiographic anatomy and common pathology	4.4.1 Confidently identify the anatomical structures displayed in images created during general radiographic examinations 4.4.2 Critically apply knowledge and recognise the radiographic appearances seen in radiographic images of the appendicular and axial skeleton, chest and abdomen for a broad range of patients types created during general radiographic examinations
	4.5 Communication	4.5.1 Synergise image appearances and health assessments using appropriate terminology 4.5.2 Demonstrate the ability to produce written descriptions / comments by using appropriate interpretation terminology 4.2.2 Recognise when it is appropriate to advise members of the health care team on the suitability of a proposed examination and when it is appropriate to refer to a medical specialist

Assessment of image interpretation competencies

It is recommended that a range of methods are employed to assess competency in image interpretation skills. Assessment should take place both within the academic and clinical setting.

Academic assessment of image interpretation skills

Suggested methods of assessment:

1. Computer-based image recognition / critique exams
2. Online image interpretation quizzes assessing human anatomy, radiographic anatomy and pathology
3. OSCE: practical assessment in simulation skills laboratories
4. Written exams
5. Case-based / assignments with image interpretation skills elements
6. Presentations: group / poster of selected trauma or pathology

Clinical assessment of image interpretation skills

1. Clinical Portfolio which includes reflective case reports; appendicular and axial skeleton, abdomen and chest radiographic skills assessment with elements of distinguishing anatomical features and recognising common pathologies or traumatic appearances on radiographs
2. Pathology portfolio to enhance image interpretation skills of pathological appearances
3. Work based performance appraisals
4. Completion of advanced clinical decision making workbook on trauma of the appendicular and axial skeleton, chest and abdomen

Respondents were asked whether their programs of study would result in graduates being able to competently assess diagnostic images as described in the proposed definition. Six of the seven universities agreed with this statement. However exploring this response further, only four universities were confident that in their opinion that graduates from their programs of study would be able to competently fulfil the criteria of the proposed image interpretation definition. The survey identified gaps within the curricula which are not delivered consistently across all universities offering accredited Australian Medical Radiation programs of study. The following table classifies key content areas which need to be covered to prepare the diagnostic radiography workforce to undertake image interpretation as described in the proposed definition.

Key image interpretation content areas		
Content Area	Description	Recommended Resources
Image interpretation search strategy	It is essential that an appropriate search strategy is adopted to encourage a systematic approach when undertaking image interpretation. The ABCs search strategy is recommended as it is easy to adopt.	Recommended textbook: Chan O: 2013 <i>ABC of Emergency Radiology</i> , 3 rd ed, Wiley- Blackwell BMJ Books
Trauma Pathology	A range of trauma and common pathological processes of the appendicular and axial skeleton, emergency chest and emergency abdomen must be included with an emphasis on recognising medical emergencies on plain film radiographs in particular of the chest and abdomen.	Recommended textbooks: McConnell, J et al: 2005 <i>Interpreting trauma radiographs</i> , Blackwell Publishing Begg, J: 2006 <i>Abdominal X-Rays made easy</i> , 2 nd ed, Harcourt Publishers Limited
Communication	Constructing a written comment requires practice and must include using appropriate descriptive terminology. This could be supported by adopting a simple crib list to ensure that all relevant detail is captured in the comment. (see example in next column) Recognising when it is crucial to communicate imaging findings to the health care team. Adopting a list of medical emergencies might be useful e.g. tension pneumothorax, toxic megacolon, unstable pelvis or spine, etc.	Crib List <ul style="list-style-type: none"> • Left or Right • Proximal or Distal • Anterior/Posterior – Inferior/Superior • Dorsal / Volar • Fracture Description • Dislocation / Subluxation

It is important to note that the process of how imaging findings will be documented must be contextualised to each clinical site. An appropriate method should be adopted to enable easy documentation of findings so as not to add an additional burden on diagnostic radiographers. Suggestions for documentation of imaging findings include the following:

- adapting the PACS system to add a comment;
- use of a radiographer opinion form; (e.g. following resource: Smith T & Young C: 2002; Accident and Emergency Radiological Interpretation: Using the Radiographer Opinion Form (ROF), The Radiographer, Vol 49 No 1

Review of Medical Imaging Advanced Level competencies for Image Interpretation Capability

An advanced-level survey was distributed to all nine Australian Universities offering accredited Australian Medical Radiation programs of study. Six universities participated in the survey. However four universities indicated that they did not offer any diagnostic radiography postgraduate programs related to image interpretation. Of the remaining two, only one university is currently offering relevant programs with the other university indicating that a relevant postgraduate program was previously offered but discontinued.

In addition to the entry level image interpretation capabilities as outlined within this document, core functions at an advanced level requires attributes of an expert clinical practitioner, capacity for decision-making and the ability to deal with complex issues, demonstrating professional leadership by facilitating continuous professional development opportunities to peers, undertakes further education in image interpretation and a practitioner who understands how research informs practice and initiates or lead on research projects.

The following **definition** is proposed for image interpretation by a radiographer working at an advanced level.

“A diagnostic radiographer working at an advanced level must possess in-depth knowledge of complex pathologies and disease processes to be able to confidently assess a range of pathologies on plain film images of the musculoskeletal skeleton, the chest and abdomen within an emergency and outpatient setting and provide a written comment or report to the medical practitioner within the scope of professional codes of conduct.”

The **scope of practice** of an advanced level radiographer in an emergency setting is proposed as:

“A radiographer practicing at an advanced level within Australia should be able to communicate and provide written comments on a range of pathologies to include both adult and paediatric plain film diagnostic images of the musculoskeletal system, abdomen and chest, demonstrate capabilities to actively promote and participate in research activities, employ professional leadership and advanced decision-making skills within the scope of professional codes of conduct.”

In order to meet the requirements of the proposed definition and scope of practice, the following units / modules are proposed for an advanced postgraduate certificate program. This could be achieved through part-time study of core units at an Australian University and work-placed based learning.

Module / Unit	Descriptor	Learning Outcomes
1. Musculoskeletal system	1.1. Advanced radiographic anatomy knowledge	1.1.1 In-depth knowledge of normal variants 1.1.2 Advanced knowledge of bone age and ossification centres e.g. CRITOL in the elbow to eliminate misinterpretation
	1.2 Advanced radiographic musculoskeletal pathology	1.2.1 Accurate identification of joint mal-alignment to identify dislocations and subluxations in the appendicular and axial skeleton 1.2.2 Identify bone density changes in bones relevant to fractures ; e.g. lucent vs. sclerotic 1.2.3 Assess images for cortical disruptions to include complex and subtle pathologies in the appendicular and axial skeleton 1.2.4 Identify epiphyseal fractures using the Salter-Harris classification 1.2.5 Recognise different types of periosteal reactions and implications for the diagnostic process 1.2.6 Evaluate soft-tissue signs indicating fractures e.g. lipohaemarthrosis and sail sign , infections and abnormal soft tissue masses 1.2.7 Discriminate between intra-and extra- articular fractures 1.2.8 Identify and discriminate between arthritides
2. The Chest	2.1 Advanced radiographic anatomy of the chest	2.1 Advanced radiographic knowledge chest structures and normal variations. 2.2 Advanced radiographic knowledge of the paediatric chest to include age-related variations and congenital abnormalities
	2.2 Advanced radiographic chest pathology	2.2.1 Identify trauma related pathologies of the chest 2.2. 1 Identify a range of chest pathology associated with trauma and out- patient settings to include tension pneumothorax, surgical emphysema, pleural effusions, lung collapse, pneumonia, chronic obstructive lung disease, acute respiratory distress syndrome, tuberculosis, fibrosis and pleural plaques related to occupational diseases e.g. asbestosis, cardiac failure, metastatic lesions, congenital conditions of the chest
3. The abdomen	3.1 Advanced radiographic anatomy of the abdomen	3.1.1 Identify variations of abdominal radiographic anatomy 3.1.2 Identify congenital conditions of the abdomen e.g. situs inversus 3.1.3 Differentiate between small and large bowel
	3.2 Advanced radiography pathology of the abdomen	3.2.1 Identify perforation of the acute abdomen 3.2.2 Identify bowel obstruction within the large and small bowel 3.2.3 Identify and localise calcifications within the abdomen 3.2.4 Identify metastatic spread to abdominal structures e.g. pelvis or spine
4. Communication	4.1. Advanced communication skills	4.3.1 Construct a succinct and accurate written and verbal comment on a range of pathologies of the adult and paediatric musculoskeletal skeletal system, chest and abdomen 4.3.2 Communicate radiographic opinions timely and effectively to the referring medical practitioner 4.3.3 Identify and implement an appropriate communication strategy within the workplace e.g. using a radiographer opinion form to convey comments
5. Leadership and research	5.4 Professional leadership and research capabilities	5.4.1 Scrutinise, evaluate and disseminate evidence based practices to improve professional clinical practice 5.4.2 Demonstrate specialised research knowledge related to image interpretation 5.4.3 Initiate and lead on research related activities within the workplace 5.4.5 Facilitate CPD activities to peers

Conclusion

It is expected that the Medical Radiation Practice Board of Australia (MRPBA) and the Australian Health Practitioner Regulation Agency (AHPRA) will include specific requirements related to image interpretation as a core skill to demonstrate that entry-level graduates are capable of providing an opinion on radiographic images of the appendicular and axial skeleton, the chest and the abdomen. Courses offering Medical Radiations programs of study need to demonstrate that their graduates meet these criteria on completion of these accredited courses. It is recommended that the image interpretation curriculum and content mapped within this review should serve as guidance for assessing accredited programs of study to ensure that entry level graduates will be able to meet the definition as proposed in this review. Furthermore it is recommended that assessment of image interpretation competencies should take place both within the academic and clinical setting and that a range of assessment methods are employed to test image interpretation competencies.

Postgraduate education and training undertaken to prepare advanced level practitioners to interpret plain film images need to ensure that these practitioners can demonstrate advanced image interpretation competencies to accurately interpret adult and paediatric plain film images of the musculoskeletal system, the chest and abdomen within the trauma and outpatient setting. In addition advanced practitioners need to demonstrate clinical expertise in image interpretation, leadership and research skills to promote and advance professional practice. It is recommended that the postgraduate certificate program mapped within this document should serve as guidance for assessing accredited postgraduate certification programs of study to meet the definition as proposed in this review.

References:

1. Australian Institute of Radiography (2007) *Guidelines for professional conduct for Radiographers, Radiation Therapists and Sonographers*; dated July 2007
2. Medical Radiation Practitioner Board of Australia / AHPRA (2013) *Draft Consultation paper: "Professional capabilities for medical radiation practice"*; dated 11 June 2013
3. Australian Health Practitioner Regulation Agency (2013) *Public consultation paper: "Consultation on common guidelines and Code of conduct"*; dated April 2013